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A Method of Measuring TRANSIT TIME for RAIL CARS

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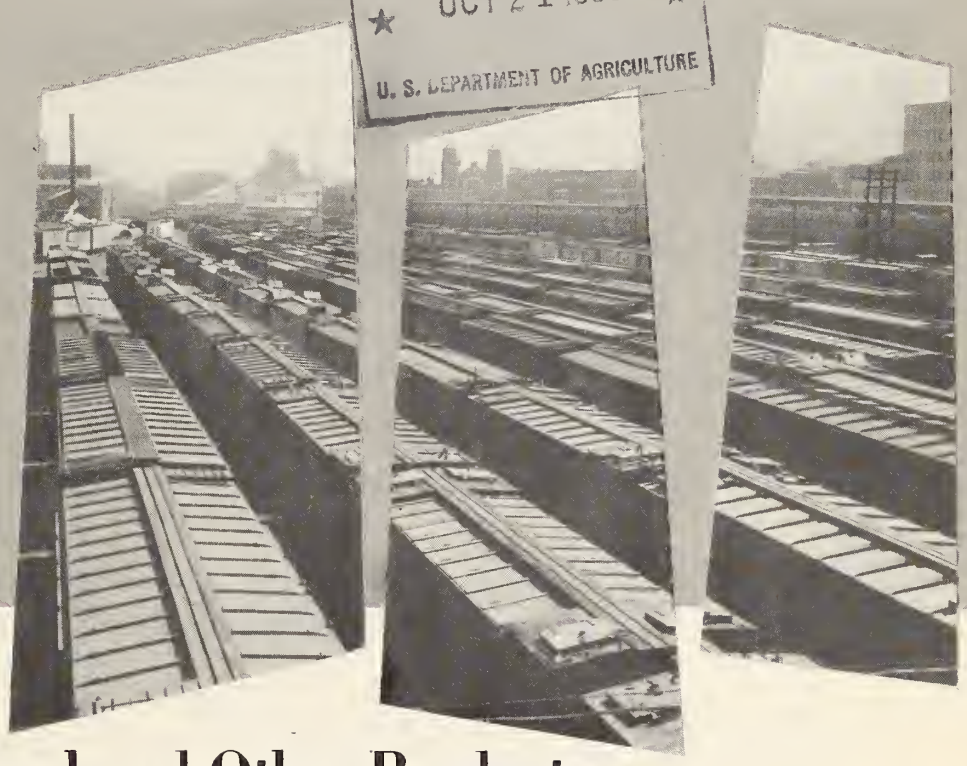

of Agricultural and Other Products

MARKETING RESEARCH DIVISION
AGRICULTURAL MARKETING SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

The study described in this report was undertaken to assist in improving transportation services and facilities for farm products by working directly with individual carriers or groups of carriers. It is part of a broad program of continuing marketing research designed to improve efficiency and hold down costs of marketing farm products.

This report offers a method by which statisticians and students of transportation may determine the average transit time of carloads between originating and terminating points. The objective is to ascertain the average miles moved in 24 hours by all carloads on line, for an index called "miles per day per loaded car." The report also shows a method of determining the relationship between the time the average loaded car is in train movement and total transit time, called the "movement ratio," for another index of carload movement. The complement of this ratio (the percentage of total time during which the car is not moving) indicates the cumulative terminal delays encountered by the average carload.

The method suggested uses data contained in reports regularly compiled by each railroad for its own purposes, and rendered to the Association of American Railroads and the Interstate Commerce Commission. The illustrative tabulation develops the method step by step. Simplification of the suggested method, and refinements in the data for greater accuracy, may be employed by the railroads having basic records and supplemental local data that are not published.

The tabulation shows a rigid pattern of carload handling since 1940. Drastic changes in traffic volume and extensive improvements in the railroad plant did not materially change carload transit time. This study did not include speculation on causes and cures affecting the railroad industry as a whole. Operating situations, such as the fixed location of large traffic centers, relay terminals, and junctions, the working rules of labor, and character of traffic, vary on different railroads. These significant factors for a given railroad are not fully available to analysts elsewhere.

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A METHOD OF MEASURING TRANSIT TIME FOR RAIL CARLOADS OF AGRICULTURAL AND OTHER PRODUCTS

By J. Edward Jay, transportation economist 1/
Transportation and Facilities Branch
Agricultural Marketing Service

INTRODUCTION

Truck transportation with its faster individualized service has increased the competitive importance to railroads of carload transit time. Prompt and dependable service is increasingly essential to shippers and receivers, mainly because progressively greater competition compels maximum efficiency and economy in their operations. The movement of raw materials, fabricated components, and finished goods must be synchronized with inventory control and production schedules. The average time required for a shipment to move from consignor to consignee has become an important measure of railroad service.

Periodic stringency of car supply at times of peak demand, often encountered at harvest time, represents a real problem to carriers serving the heavy grain producing regions of the country. In addition to improving the competitive situation for railroads, expedited carload transit time will improve car utilization. Earlier arrival and placement for unloading releases the car sooner for reloading. A reduction of 1 day in the turnaround time between loadings of 1,800,000 serviceable cars (from 16 to 15 days) would increase availability for reloading equivalent to more than 100,000 additional cars. Purchased new, that many cars would cost over $800 million.

An abundance of statistics concerned with financial and operating results of the Nation's railroads are published monthly, quarterly, and annually by the Interstate Commerce Commission and the Association of American Railroads. However, no direct measure of performance in the service accorded by the railroads to the shipping public, comparable to various quality control indexes employed in other industries, is available.

The Interstate Commerce Commission has recognized this need. In a recent decision involving a petition of the railroads for increases in freight rates it said:

> Notwithstanding the reduced financial position described above, taking all factors into consideration, railroad operations are being more efficiently and more economically performed today than ever before. Forward strides in improving the efficiency, economy, and adequacy

1/ Mr. Jay is now with the Post Office Department.

of their operations are to be seen in the additions and betterments made to their properties during the years 1956 and 1957, including increases in ownership of freight cars and diesel locomotive units, improved signaling systems, and modernized yard and terminal operations. Some railroad performance averages, moreover, in the first four months of 1958 were at new all-time highs; freight trains averaged 19.3 miles per hour between terminals, averaged 70.3 cars per train, and turned out 60,401 gross ton-miles per hour of operation. In recent months, however, due to the smaller volume of available traffic and the resulting idling of serviceable equipment, load factors per car and equipment utilization per serviceable unit generally have declined. There is still much to be accomplished in the matter of railroad efficiency particularly as to movements through origin, intermediate, and destination terminals, which are apparently the cause of the delays in transit referred to in the discussion under Category D, Free Time at the Ports. The improvement in running time between terminals is not particularly significant if it is to be nullified by delays within the terminals themselves. Railroads need "quality control"--a quick and accurate measure of the speed of their entire service (shipper to consignee). When a "service ratio" is established and watched as closely by top management as the transportation and operating ratios are now watched, justifiable complaints about the quality of railroad service should rapidly decline. 2/

THE PROBLEM

Carload transit time is defined as the entire period of the railroads' responsibility to move the carload from consignor to consignee. For the individual railroad, the period commences when the bill of lading is signed (or equivalent incident), or when the car is received on an interchange track; and the period ends when the car is placed for unloading, or delivered on an interchange track.

It is impracticable for railroads to expedite the transit time of each individual carload shipment, as truck companies do. Railroads are located to operate freight trains hauling many carloads between different stations. The train is the basic operating unit, and one of the principal elements of direct cost. Construction, maintenance, and other undertakings are planned to improve train operation. Except for a limited number of scheduled "time-freight" trains, such as the more important perishable and livestock schedules, day-to-day train dispatching contemplates the maximum number of carloads per train, with subordinated consideration being given to time schedules. Increasing the number of carloads per train will decrease the direct cost of hauling a carload unit of revenue freight between terminal points. Consequently, periodic comparisons of operating results based upon trainload efficiency influence operating policies and practices. When unrestrained by other important objectives, maximum carloads per train usually become a rigid minimum standard, restricted only by engineering limitations.

2/ Ex Parte No. 212, Increased Freight Rates, 1958, Appendix, Sheet 5.

Long freight trains retard movements of all trains between termini unless the sidings are lengthened and train speed increased. Moreover, additional time is consumed in terminals in assembling sufficient carloads to make up a maximum trainload. Since World War II the railroads have improved train performance between termini by using diesel locomotives and installing additional trackage, extensive signal controls, and communication systems. As a result of these and other improvements, train performance between 1946 and 1957 as measured by loaded car-miles per train-mile per hour, increased 30 percent, from 555 to 808 (table 1, items E and V). 3/ However, the distance the average carload on line moved daily has not changed materially (table 1, item K). Apparently the time saved by longer and faster trains between termini was added to the terminal detention.

A possible solution is to compromise the two extreme operating objectives: (1) Fast movement of individual carloads, similar to truck service; and (2) maximum trainloads, with comparatively slow transit time. To find an economically feasible operating objective between these extremes more information is needed regarding carload transit time. Such carload information, as complete and dependable as information on train performance, has not been readily available. A principal reason for this deficiency is the predominant interline movement of carload traffic. Cars are loaded, interchanged, and unloaded as single units but are moved collectively in switching units and road train units over each participating line haul railroad. Frequently they also move through one or more separate terminal railroads. Consequently it is difficult to assemble complete data on carload handling, particularly through a sequence of interchanges and intermediate terminals.

By comparison, complete data on train movements are readily available, although they do not disclose the movement of individual carload shipments. Since substantial reductions in average carload transit time will oppose technically correct trainload standards, the data on overall carload transit time should be equally complete and comparable for joint analysis by the participating railroads. This was pointed out by the Interstate Commerce Commission, as quoted in the introduction to this report.

MEANS OF REDUCING TRANSIT TIME UNDER STUDY

Carload transit time is currently being considered by the railroads. 4/ Extensive and expensive sampling surveys have been made in the past to obtain estimates of carload performance, and to ascertain the type and extent of changes in operating policies desired and economically feasible. For example, the Federal Coordinator of Transportation made a 1-day survey of carload transit time covering over 60,000 carloads terminating on December 13, 1933. Although the results of a 1-day survey and analysis

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3/ Loaded car-miles per train-mile multiplied by average train speed.

4/ American Railway Engineering Association, a division of Association of American Railroads, Committee 16, Economics of Railway Location and Operation, on its Assignment 5, titled, "Comparison of Running Time with Total Time Between Loading and Unloading Points of Freight Cars, and Methods of Reducing Total Time."

can scarcely be representative of average carload transit time, either today or in 1933, the Coordinator's data have been generally accepted as the best information available. 5/ Spot checks to obtain transit time averages have also been made by individual railroads and others. 6/ Data obtained by spot checks and other empirical methods are inadequate to influence significant changes in long-established operating methods. Train performance indexes developed with standard statistics have provided reliable tests for operating policy guidance. Equally dependable mass data should be developed regarding carload handling, particularly carload transit time.

METHOD OF DETERMINING TRANSIT TIME SUGGESTED

This study suggests a method by which the transit time of the average carload can be determined with mass data. The data used are regularly compiled by each railroad for periodic reports rendered to the Association of American Railroads and the Interstate Commerce Commission. The primary target of the method is to calculate the average distance that all carloads on line move in 24 hours. It may be called "miles per day per loaded car." The number of days in transit is the average miles per carload haul divided by this average daily distance.

Another index of carload movement is the percentage of the time that the average carload is in a train between railroad division points or terminals. Obviously, reduction of the time spent in handling loaded cars through these terminals presents the greatest opportunity for overall improvement in railroad service. These carload movement indexes are developed in table 1, items K, L, and Y.

Data for 4 years--1940 (prewar), 1946 (postwar), 1952, and 1957--included in this table indicate that there has been little improvement in the performance factors mentioned since before World War II, despite the increase in the average speed of freight trains shown in item V.

The source or derivation of each item of data used in table 1 is shown in the "Data Description" column.

Item A, Daily Average Carloads Terminated

The basic information on daily average carloads terminated is obtained from the revenue and nonrevenue carloadings reported by each Class I railroad in the "Weekly Equipment Loading Report," published by the Association of

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5/ "Freight Traffic Report" issued by the Federal Coordinator of Transportation in 1935, vol. II, p. 71. Cited by Beckman, McGuire, and Winsten, in "Studies in the Economics of Transportation," published for Cowles Commission for Research in Economics by the Yale University Press, New Haven, in 1956; on p. 123 the authors said, "These time estimates (Federal Coordinator's) from a single day in 1933 seem to be about the only public available source of such information."

6/ Proceedings * * * 1956 * * * American Railway Engineering Association, progress report on Assignment 5 by Committee 16 (Supra), vol. 57, pp. 321 and 946.

Table 1.--Illustrations of a method for estimating carload transit time, based upon the percentage of terminating carloads in an average freight train

Item	Annual data, Class I railroads treated as a single railroad system — Data description and source		1957	1952	1946	1940
A.	Carloadings on Class I railroads, plus 5 percent loaded elsewhere (AAR CS 54-1) 1/	(000)	39,399	42,755	47,072	41,398
	Daily average carloads terminated (A ÷ 365)		107,942	117,136	128,964	113,419
B.	Loaded car-miles (ICC OS-A, Item 4-03; M-211) 2/	(000,000)	19,068	19,827	20,224	14,699
	Daily average loaded car-miles (B ÷ 365)	(000)	52,241	54,320	55,408	40,271
C.	Average miles per carload haul (B ÷ A)		484	463	430	355
D.	Train-miles, ordinary (ICC OS-A, Item 2-08) 2/	(000)	442,360	497,268	582,626	477,618
E.	Loaded car-miles per train-mile (B ÷ D)		43.0	39.8	34.7	30.7
F.	Average miles per train crew (Data M through S)		106.4	103.7	103.8	104.0
G.	Number of trains operated (crews used, D ÷ F)	(000)	4,150	4,708	5,612	4,475
H.	Carloads terminated per train operated (A ÷ G)		9.5	9.1	8.4	9.3
I.	Percent of carloads terminated per train $\left(\frac{H}{E} \times 100\right)$		22.0	22.9	24.2	30.3
J.	Carloads on line daily $\left(\frac{\text{A-daily}}{I} \times 100\right)$		490,000	511,500	533,000	374,000
K.	Miles per day per loaded car (B-daily ÷ J)		106.6	106.3	104.0	107.7
L.	Average carload transit time in days (C ÷ K)		4.5	4.4	4.1	3.3
	Crews used, ICC M-300 "Wage Statistics," Lines 113-114: 3/					
M.	Conductors' actual miles-through trains	(000)	288,446	340,718	436,231	327,560
N.	Conductors' actual miles-local/way trains	(000)	184,414	201,257	210,255	190,079
O.	Conductors' train trips-through trains	(000)	2,445	2,951	3,792	2,804
P.	Conductors' train trips-local/way trains	(000)	1,998	2,274	2,435	2,171
Q.	Average miles per through freight train (M ÷ O)		117.9	115.5	115.3	116.8
R.	Average miles per local/way freight train (N ÷ P)		92.4	87.6	86.3	87.5
S.	Average miles per crew (M + N) ÷ (O + P) = Data F		106.4	103.7	103.8	104.0
T.	Train-hours, including way station switching (ICC OS-A, Item 8-07; M-211) 2/	(000)	23,740	28,566	36,820	28,908
U.	Percent of train hours for train switching (ICC OS-A, Item 15; M-211) 2/		22.2	20.9	17.8	20.8
V.	Average speed of freight trains (D ÷ T)		18.8	17.6	16.0	16.7
W.	Average carload transit time in hours (L x 24)		108.0	104.6	99.4	79.2
X.	Average carload-hours in trains (C ÷ V)		25.7	26.3	26.9	21.3
Y.	Movement ratio $\left(\frac{X}{W} \times 100\right)$	(Percent)	23.8	25.2	27.0	26.9

1/ Association of American Railroads, Car Service Division. Weekly Equipment Loading Report CS 54-1A.
2/ Interstate Commerce Commission, Bureau of Transport Economics and Statistics. Freight Train Performance of Class I Railroads in the United States. Statement No. M-211 (OS-A).
3/ Interstate Commerce Commission, Bureau of Transport Economics and Statistics. Wage Statistics of Class I Railroads in the United States. Statement No. M-300.

American Railroads (AAR) in Report Form CS 54-1A. When applying these data to all railroads as a single system the total Class I carloadings should be increased to include unreported carloads. These unreported carloads also contribute to the loaded car-miles used in the calculations. They are the cars loaded on small nonreporting railroads, and loaded on railroads in Canada and Mexico and received at border junctions. For table 1 the unreported carloadings were estimated at 5 percent of reported carloadings.

In calculating item A for any individual railroad the revenue carloads received from connections must be added to the carloadings it reports to the AAR in CS 54-1A. These additional carloads are reported separately in AAR CS 54-1A and include unreported carloads mentioned above.

As an average figure, the carloads terminating will be the same as the carloads originating, because, over a substantial period of time, annually or monthly, there will be no material difference between the number of cars loaded within the period which were still in movement at its end, and the cars originated earlier that terminated after the period began. Consequently, the daily average carloadings in item A may be designated "carloads terminating daily."

Item F, Average Miles Per Train Crew

These data are used to ascertain the number of freight trains operated as shown in item G. Each train is represented by a conductor's wheel report per train crew. The reported train-miles (item D) divided by the average miles per crew (from conductors' reports) gives the number of trains operated. To measure its own performance the individual railroad may count the number of wheel report documents. One document signed by several conductors would be one wheel report or train.

However, the same information of another railroad must be obtained from monthly "Wage Statistics" reports rendered to the Interstate Commerce Commission (ICC), as shown in items M through S. The M-300 report published by the ICC gives the total figures for all Class I railroads, but not for individual railroads. The report rendered monthly by each Class I railroad may be examined in the Public Reference Room, ICC, Washington, D. C., and a copy obtained for a small fee. The conductor's report of mileage is divided by the related number of trips to obtain the average miles per train operated. The number of trips reported in M-300 also indicates the number of trains, but may be less accurate than using the average miles per train crew as a divisor of the train-miles.

Item H, Carloads Terminated Per Train Operated

The suggested method develops patterns of carload handling with the standard statistics reported to the AAR and ICC. Loaded cars moved collectively in a train are statistically represented by the reported loaded car-miles per train-mile, or may be calculated as shown in item E. The movement of the average carload is reflected in the daily disposition of carloads in this

"statistical train," shown in item E. Part of the carloads that make up this representative train will terminate daily, either at the final destinations or by delivery to a connecting line. The portion is converted to a percent of the train load, shown in item I. The remaining carloads will continue until all have terminated. The number of days required to dispose of all carloads in this representative or "statistical" train is a measure of the average carload transit time, item L.

Item J, Carloads on Line Daily

The percentage of carloads in the average train that terminate daily (item I) is applied to all carloads terminating daily (item A) and raised to 100 percent. That is, divide daily terminations on the entire railroad by the percentage of daily terminations per average train and multiply the quotient by 100. This will provide an estimate of the carloads on line that are in movement status (moved in a train at least once during each successive 24-hour period).

Item K, Miles Per Day Per Loaded Car

Miles per day per loaded car are calculated by dividing the daily average loaded car-miles (item B) by the estimates of carloads on line (item J).

Similar results may be obtained by applying the percentage of terminated carloads per average train (item I) to the average haul (item C), or using the ratio of "statistical trains" daily to actual trains daily. 7/ However, more accurate results can be obtained by adding carloads delayed over 24 hours to the ascertained carloads on line in movement status. Railroads make a special effort to eliminate 24-hour delays at one station. Therefore, it may be presumed for illustrative purposes that all carloads on line are moved in a road train at least once in each 24 hours. If the number of carloads delayed over 24 hours at one station is large enough to change the averages and ratios, they should be added to item J. Of course, such increase in carloads on line will decrease the miles per day per loaded car.

Item Y, Movement Ratio

Movement ratio is the percentage of total time in line haul movement that the average carload is in a train. The complement (percentage of total time during which the car is not moving) indicates the extent of terminal delay. It is ascertained by dividing the total hours in a train by the total hours between originating and terminating stations. The hours in a train are obtained by dividing the average haul (item C) by the average speed of trains (item V). The average speed of trains may be based upon train hours that either include

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7/ The statistical train is represented by "loaded car-miles per train-mile." The number of statistical trains daily is obtained by dividing carloads terminated daily by "loaded car-miles per train-mile."

or exclude the hours applied to switching at way stations between terminals. Item Y in table 1 retains the way switching hours and shows the greater movement ratio. The alternative would be to reduce the train hours shown in item T by the percent shown in item U, and correspondingly reduce the movement ratio. A lower movement ratio would increase the complement for a more accurate index of terminal delay. Delays of carloads resulting from meeting trains, power and equipment failure, track conditions, obstructions, derailments and other causes are incidental to train operation. But delay of a train placed on a siding while its locomotive performs unrelated switching service is a form of terminal delay of the carloads in that train.

DATA LIMITATIONS

The formula illustrated by table 1, as applied to all Class I railroads as a single system, provides a method of measuring the total time in line haul movement of carloads recorded on one or more wheel reports. The sequence of 24-hour periods begins when the carload is first entered on a wheel report document at its originating station. The final 24-hour period or fraction thereof in the sequence ends when the carload arrives at its terminating station. Therefore, the total time in line haul movement is less than the transit time from consignor to consignee defined earlier. Omitted is the period after signing the bill of lading until initial train movement, and the period after train arrival at the terminating station until delivered to the consignee.

In treating all Class I railroads as a single system without interline traffic, the movement of cars through an interchange point is similar to the movement through an intermediate terminal on an individual railroad. However, on an individual railroad having interline traffic the time consumed at interchange must be accounted for, since it is also omitted in the reported data available.

The time data for the omitted periods before and after line haul movement are readily available to the railroad's analyst from local station records, although they are seldom compiled and reported. If the omitted periods on an individual railroad are large enough to change the averages and ratios materially, the objective indexes of "miles per day per loaded car" and "movement ratio" should be adjusted accordingly.